



# DECUS

## PROGRAM LIBRARY

DECUS NO.	8-169H
TITLE	DISTANCE AND BEARING
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COMPANY	Submitted by: Joann E. Gavan Atlantic Oceanography Laboratory Bedford Institute Dartmouth, Nova Scotia, Canada
DATE	
SOURCE LANGUAGE	

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# DECUS

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## 1. IDENTIFICATION

- 1.1 Number: OCDA-8-08 (P-08-01)
- 1.2 Title: DISTANCE AND BEARING
- 1.3 Date: May 1968
- 1.4 Computer: PDP-8
- 1.5 Language: PAL III

## 2. ABSTRACT

The distance and bearing are calculated for two positions specified by their latitudes and longitudes.

## 3. REQUIREMENTS

- 3.1 Storage: 5 - 7, 40 - 104, 200 - 577, 4600 - 7577
- 3.2 Subprograms and/or Subroutines
  - 3.2.1 F.P. Package (Digital 8-5D-S)
- 3.3 Equipment: Teletype

## 4. USAGE

- 4.1 Loading: The Binary loader (Digital-2-U) is used to load the F.P. Package followed by the program.
- 4.2 Calling Sequence: N/A
- 4.3 Switch Settings: N/A
- 4.4 Start up and/or Entry: The program is started at loc. 200<sub>g</sub>. Then the positions are typed on the teletype.
- 4.5 Errors in Usage and Recovery: A space is the only legal terminating character. If any other terminating character is read, the preceding number is ignored, (i.e. all digits typed between the last space and the illegal terminating character). To continue it is necessary to retype the number.

## 5. RESTRICTIONS N/A

## 6. DESCRIPTION

- 6.1 Discussion: The program calculates the distance and bearing between positions. Initially the program requires two positions, but only one thereafter. The distance and bearing between the last two stations typed are calculated. All I/O is on the teletype.
- 6.2 Examples and/or Applications: Given in Fig. 1

## 7. METHODS

- 7.1 Discussion: N/A

44	23.8	63	28.2		
44	15.5	63	19.5	+0019.24	+036.96
43	52.8	62	53.2	+0054.78	+039.87
43	28.8	62	27.2	+0056.53	+038.18
43	10.6	62	06.3	+0043.98	+039.98
42	50.8	61	44.1	+0047.48	+039.45

Figure 1

7.2 Algorithm: The following equations are used to find the geodetic distance between two points given their latitudes and longitudes:

$$S \sin \alpha = \frac{\Delta \lambda \cos \phi_m}{A_m} = U$$

$$S \cos \alpha = - \frac{\Delta \phi \cos \frac{\Delta \lambda}{2}}{B_m} = V$$

$$A_m = \frac{(1 - e^2 \sin^2 \phi_m)^{1/2}}{a \sin I''}$$

$$B_m = \frac{(1 - e^2 \sin^2 \phi_m)^{3/2}}{a(1 - e^2) \sin I''}$$

where  $\lambda_1, \lambda_2$ : longitude of the two points

$\phi_1, \phi_2$ : latitudes of the two points

S: distance between positions

$\phi_m$ : mean latitude

$\alpha$ : azimuth

e: eccentricity  $e^2 = .0067686275$

a: equatorial semi-axis

b: polar semi-axis

$\sin I''$ : permits  $\Delta \lambda$  to be expressed in seconds.

$$\Delta \lambda = \lambda_1 - \lambda_2$$

$$\Delta \phi = \phi_1 - \phi_2$$

$$\frac{1}{a \sin I''} = .032559$$

$$\frac{1}{a(1 - e^2) \sin I''} = .032559$$

## 8. FORMAT

8.1 Input Data: Each position is given by four numbers which represent the latitude and longitude in degrees and minutes. The terminating character for each number is a space.

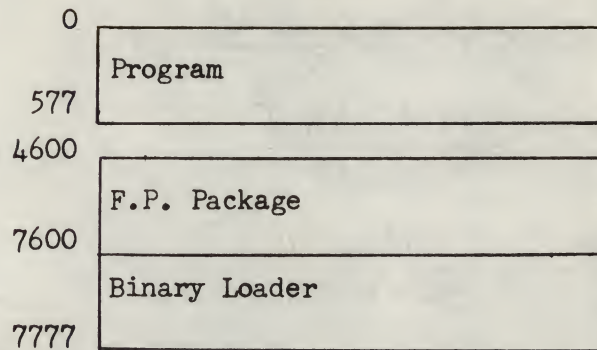
8.2 Core Data: N/A

8.3 Output Data: The O/T record consists of the distance in kilometers and the bearing in degrees (+xxx.xx +xxx.xx). Note that if the bearing is a multiple of 90, a series of x's will be printed.

9. EXECUTION TIME N/A

10. PROGRAM

10.1 Core Map:



10.2 Dimension List: N/A

10.3 Macro, Parameter, and Variable List: This is included with the listing of the program.

10.4 Program Listing: Attached at the end of the program write-up.

11. DIAGRAMS

11.1 Flow Chart: Shown in Fig. 2

12. REFERENCES

12.1 Other Library Program:

12.1.1 F.P. Package (Digital 8-5D-S)

12.2 Digital Manuals:

12.2.1 F.P. Manual (Digital 8-5-S)

12.3 DECUS Programs:

12.3.1 Modification to Fixed Point O/T in the PDP-8 F.P. Package (Decus No. 8-44)

12.4 Textbooks:

12.4.1 U.S. Coast and Geodetic Special Publication #8

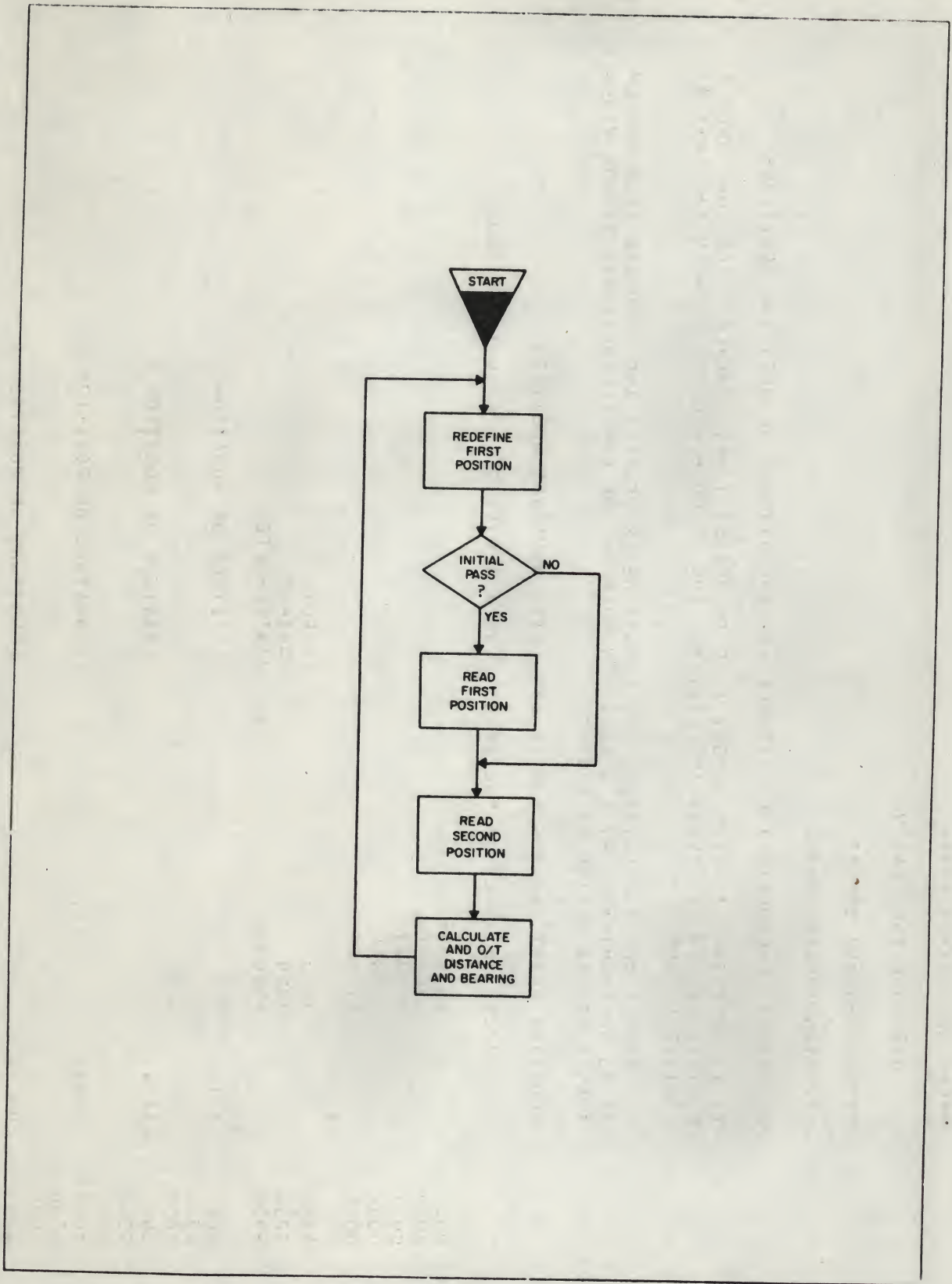


Figure 2

```

/***** OCDA-08-08 *****/
/
/ DISTANCE AND BEARING
/
/***** P-03-01 *****/
/
/STARTING ADDRESS *200*
/
/PROGRAM TO CALCULATE THE DISTANCE AND THE AZIMUTH BETWEEN TWO POSITIONS
/
/IT IS NECESSARY TO TYPE 2 POSITIONS THE FIRST TIME, HOWEVER AFTER THAT ONLY 1
/POSITION IS TO BE TYPED. THE DISTANCE AND AZIMUTH WILL BE BETWEEN THE LAST 2
/POSITIONS TYPED.
/
/THE FORMAT FOR THE LATITUDE AND LONGITUDE IS DEGREES AND MINUTES. EACH NUMBER
/IS TO BE TERMINATED BY A SPACE. A NUMBER MAY BE CANCELLED BY ANY SYMBOL OTHER
/THAN A DIGIT, PERIOD OR A SPACE
/
/FLOATING POINT PACKAGE *D* IS USED WITH ROUNDING ADDITION
/
/ON OUTPUT, IF ANGLE IS MULTIPLE OF 90 A SERIES OF X FILL THE FIELD.

```

```

0001 SQUARE=1
0002 SQR00T=2
0003 FSIN=3
0004 FCOS=4
0005 ARTN=5
0005 *5
0005 7400
0005 7200
0006 5600
0007
0053 *53
0053 LAT1,
0053
0064
0065
0055
0057
0070
0071
0072
0073
0074
0075

```

```

/INPUT
/OUTPUT
/INTERPRETER
/LATITUDE OF POSITION 1
/LATITUDE OF POSITION 2
/LONGITUDE OF POSITION 1
/LONGITUDE OF POSITION 2

```



0075			
0077	ANGLE,		/AZIMUTH ANGLE
0100			
0101			
0102	A,	7772	/CONVERSION DEG TO RAD. DIV. BY 2
0103		2167	/.8726646E-2
0104		5432	
0105	RELL,	207	
0200	*20C		
0200		TLS	
0201		CLA CMA	
0202		DCA FIRST	
0203	REGIN,	JMS I 7	/FLAG FOR THE FIRST POSITION
0204		FGET LAT2	/INITIALIZE
0205		FPUT LAT1	
0206		FGET LONG2	
0207		FPUT LONG1	
0210		FEXT	
0211		TAD A+1	/SET ANGLE TO LARGE NUMBER
0212		DCA ANGLE	
0213		ISZ FIRST	/CHECK IF THE FIRST POSITION
0214		J1P REG	/NO
0215		JMS I FREAD	/READ THE FIRST LAT.
0216		LATI	
0217		J1S I FREAD	/READ THE FIRST LONG.
0220		LONG1	
0221		JMS I FREAD	/READ NEXT LAT.
0222	REG,	LAT2	
0223		JMS I FREAD	/READ NEXT LONG.
0224		LONG2	
0225		JMS I 7	
0226		FGET LAT2	
0227		FADD LAT1	/A(LATI+LAT2)
0230		F4PY A	/SIN(A(LATI+LAT2))
0231		FSIN	
0232		SUARE	/R(SIN(A(LATILAT2)))**2)=PI
0233		FMPY R	
0234		FPUT TEMP	
0235		F3ET C	/((C-PI)
0236		FSUR TEMP	
0237		FPUT X	
0240		SQR00T	
0241		FMPY D	/D*((C-PI)**1/2)



0315  
0316  
0317  
0320  
0321  
0322  
0323  
0324  
0325  
0326  
0327  
0330  
0331  
0332  
0333  
0334  
0335  
0336  
0337  
0340  
0341  
0342  
0343  
0344  
0345  
0346  
0347  
0350  
0351  
0352  
0353  
0354  
0355  
0356  
0357  
0360  
0361  
0362  
0363  
0364  
0365  
0366  
0367

7650  
5335  
4407  
5363  
4366  
0005  
6077  
0003  
6360  
5363  
4360  
6366  
0000  
4743  
0366  
5740  
4743  
0353  
5740  
0525  
0000  
0473  
0430  
7771  
3356  
2656  
0001  
2000  
0000  
7774  
2043  
5363  
7774  
2052  
7200  
0000  
0000  
0000  
0000  
0000  
0000  
0000  
0000  
0000  
0000

SVA CLA  
J4P DISTT  
J4S I 7  
FGET AM  
FJIV RM  
ARTN  
FJIT ANGLE  
FSIN  
FPUT TEMP  
FGET AM  
FJIV TEMP  
FPUT RM  
FEXT  
J4S I FPRINT  
RM  
J4P I END  
J4S I FPRINT  
AM  
J4P I END  
ENDP  
U  
GREAD  
PRINT  
7771  
3356  
2656  
0001  
2000  
0000  
7774  
2043  
5363  
7774  
2052  
7200  
U  
0  
0  
0  
0  
0  
0  
0  
AM,  
RM,  
TEMP,  
R,  
C,  
D,  
E,  
TEMP,  
AM,  
RM,

/CHECK IF V=0  
  
/ARC TAN(U/V)  
/SIN(ARC TAN(U/V))  
/U/SIN(ARC TAN(U/V))  
/STORE DISTANCE IN LOC BM  
/U=0, THEREFORE DISTANCE=V  
/V=0, THEREFORE DISTANCE=U  
  
/ECCENTRICITY SQUARED=.0067686275  
/CONSTANT=1  
/1/ASINI=.0323339  
/1/A(1-E\*\*2)SINI=.032559

0370									
0371	W,	0000							
0372	X,	6000							
0373		0000							
0374		0000							
0375	F,	0014							
0376		3410							
0377		0000							
0400									
0400	READ,	0000							
0401		4405							
0402		7200							
0403		1060							
0404		7650							
0405		5201							
0406		1057							
0407		1221							
0410		7640							
0411		5223							
0412		1500							
0413		3222							
0414		4407							
0415		5622							
0416		0000							
0417		2200							
0420		5600							
0421		7540							
0422		0000							
0423		1105							
0424		4257							
0425		4257							
0426		4257							
0427		5201							
0430		0000							
0431		7200							
0432		3055							
0433		1265							
0434		3267							
0435		1264							

/ADDRESS TO TAKE -VE OF NUMBER

/CONST=3600

/SUR TO READ AND STORE A NUMBER, PROVIDED THE TERMINATING CHAR WAS A BLANK,  
/OTHERWISE IGNORE

/READ NUMBER

/CHECK IF LEGAL INPUT

/CHECK IF LEGAL TERMINATING CHAR

/STORE NUMBER

/SUR TO OUTPUT 6 SPACES AND THE DISTANCE IN KM.  
/ ILLEGAL CHARACTER WAS READ

ERROR;

PRINT;

0436	JMS OUT	4257
0437	ISZ TEMP2	2257
0440	JMP --2	5236
0441	CLA	7200
0442	TAD I PRINT	1630
0443	DCA TEMP2	3267
0444	JMS I 7	4407
0445	FGET I TEMP2	5667
0446	FDIV F1000	4270
0447	FEXT	0000
0450	TAD SIX	1265
0451	CIA	7041
0452	DCA 62	3062
0453	TAD TWO	1266
0454	JMS I 6	4406
0455	ISZ PRINT	2230
0456	JMP I PRINT	5630
0457	OUT,	0000
0460	TSF	5041
0461	JMP --1	5260
0462	TLS	6045
0463	JMP I OUT	5657
0464	SPACE,	0240
0465	SIX,	7772
0466	TWO,	0002
0467	TEMP2,	0000
0470	F1000,	0012
0471	3720	3720
0472	0	0000
0473	/SUB TO READ LAT AND LONG AND CONVERT TO DEGREES AND FRACTION OF DEGREES.	0000
0474	GREAD,	7200
0475	CLA	1673
0476	TAD I GREAD	3321
0477	DCA TEMP3	4200
0500	JMS READ	0513
0501	LAT	4200
0502	JMS READ	0516
0503	LATT	4407
0504	JMS I 7	5316
0505	FGET LATT	4322
0506	FJIV LATH	1313
0507	FADD LAT	6721
	FPUT I TE'103	

/CONVERT FROM METRES TO KM.

/OUTPUT DISTANCE

/OUTPUT SPACE

/CONSTANT=1000

/READ NUMBER

/READ NUMBER

/CONVERT MINUTES TO DEGREES

/STORE

0510	0000	FEXT	
0511	2273	ISZ GREAD	
0512	5673	J4P I GREAD	
0513	0000		
0514	0000		
0515	0000		
0516	0000		
0517	0000		
0520	0000		
0521	0000		
0522	0006		/CONSTANT=60
0523	3600		
0524	0000		
/SJR TO OUTPUT AZIMUTH ANGLE			
0525	7240	CLA CMA	
0526	3055	DCA 55	
0527	1264	TAD SPACE	
0530	6041	TSE	
0531	5330	JMP --1	/OUTPUT SPACE
0532	6046	TLS	
0533	4407	JMS I 7	
0534	5077	FGET ANGLE	/CONVERT ANGLE TO DEG.
0535	4102	FJIV A	
0536	4352	FJIV F2	
0537	0000	FEXT	
0540	1351	TAD FIVE	
0541	3062	DCA 62	
0542	1266	TAD TWO	
0543	4406	JMS I 5	
0544	7300	CLA CLL	/OUTPUT ANGLE
0545	1105	TAD BELL	
0546	4257	JMS OUT	
0547	5750	JMP I REGG	
0550	0203	REGIN	
0551	0005	S	/CONSTANT=2
0552	0002	F2,	
0553	2000		
0554	0000		
4762	*4762		/ TO PUT IN LEADING ZEROS ON O/T
4762	0000		

AM	0353
ANGLE	0077
ARTN	0005
A	0102
REGG	0550
REGIN	0203
REG	0221
RELL	0105
RM	0356
R	0344
C	0347
DIST	0332
DISTT	0335
D	0352
EVNP	0525
END	0340
ERROR	0423
E	0355
FIACC	0470
F2	0552
FCOS	0004
FIRST	0341
FIVE	0551
FPRINT	0343
FREAD	0342
F	0375
FSIN	0003
GREAD	0473
LATI	0063
LAT2	0966
LATH	0522
LAT	0513
LATT	0516
LONG1	0071
LONG2	0074
M3A	0421
OUT	0457
PRINT	0430
READ	0400
SIX	0455
SPACE	0464
SQPOOT	0002
SQUARE	0001

TEMP1	0422
TEMP2	0467
TEMP3	0521
TEMP	0360
TWO	0466
W	0371
X	0372

